Governing knowledge

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02.THE C0PR0DUCTI0N 0F KN0WLEDGE AND P0LICY IN C0ASTAL G0VERNANCE: INTEGRATING MUSSEL FISHERIES AND NATURE REST0RATI0N

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Abstract

One of the challenges of coastal governance is to connect a variety of knowledge systems. The purpose of this paper is to show how a coastal governance practice can emerge and stabilize, such that actors with disparate knowledge systems collaborate towards the shared goal of sustainable resource use. We analyze this stabilization in terms of the coproduction of knowledge and policy. This paper is empirically informed by a case study on the transition towards a sustainable mussel fishery in the Dutch Wadden Sea. Our study illuminates the difficulties of underpinning a coastal governance practice with scientific research, since the relevance, quality, and results of research are interpreted differently from the perspectives of resource users and conservationists. Furthermore, our analysis shows that such a governance practice can stabilize through a combination of rule negotiation, legal, societal, and political pressure, along with collaborative knowledge creation. Based on our analysis, we identify several aspects of collaborative knowledge creation that enable the formation of a shared knowledge base for governance in a context of controversy. These include the shared ownership of research, knowledge creation as an integral part of governance, a focus on data and basic facts, and the close involvement of trusted experts. The findings of this study suggest that a controversial setting strongly structures knowledge creation, while at the same time knowledge creation enables coastal governance as a way of dealing with conflicts.

2.1 INTRODUCTION

In coastal areas worldwide, tensions exist between ecological conservation and economic development. Such tensions often lead to conflicts between different actor groups and institutions with contrasting interests in coastal zones. Coastal governance has emerged as a key mode of dealing with such conflicts. In the context of coastal management, governance is often seen as an interactive form of policy-making or management, in which governmental and non-governmental actors collaborate in order to deal with social and ecological problems in coastal areas (Cicin-Sain & Belfiore, 2005; Jentoft, 2007; Frangoudes et al., 2008). Coastal governance practices are characterized by interdependence and the distribution of power and competences among the actors involved in coastal management issues (Folke et al., 2005; De la Torre-Castro, 2012). This paper investigates a case of a coastal governance practice in the Dutch Wadden Sea that integrates a transition towards a sustainable mussel fishery with a process of nature restoration.

In the coastal management and marine policy literature a number of governance-related principles can be discerned, which include adaptivity,

integration, and inclusion. Adaptivity in management approaches is deemed necessary in order to deal with uncertainty, along with the social and ecological complexity of coastal zones, and to promote the resilience of coastal systems (Berkes & Turner, 2006; Lane, 2008; Rijke et al., 2012). Integration is a key principle of coastal governance, as exemplified by the rise in integrated coastal zone management (ICZM). This form of management aims at dealing with the multiplicity of uses, actors, stakes, and environments in coastal zones by integrating sectors, governmental levels and policies, spatial and temporal scales, and science and policy (Cicin-Sain & Belfiore, 2005; Shipman & Stojanovic, 2007; Lane, 2008; Portman et al., 2012). Furthermore, inclusion of stakeholders is a key principle, as exemplified by the application of comanagement in fisheries governance (Trimble & Berkes, 2013).

This adaptive, integrative, and inclusive character has consequences for the roles of knowledge in coastal governance. In this paper we will expand on two knowledge-related themes that figure prominently in the coastal governance literature. First, knowledge in the context of coastal governance is often described as a diverse, fragmented, and situated phenomenon (O'Toole & Coffey, 2013). An integrated approach, for instance, necessitates a diverse, interdisciplinary, scientific knowledge base (Bremer & Glavovic, 2013a). Furthermore, due to the inclusion of multiple actors with multiple backgrounds and worldviews, "other-than-scientific" knowledge plays an important role in coastal governance. Such other types of knowledge are conceptualized in terms of, for example, experience-based knowledge (Berghöfer et al., 2008), traditional ecological knowledge (Berkes & Turner, 2006), fishermen's ecological knowledge (Holm, 2003), and local (ecological) knowledge (Gerhardinger et al., 2009; Bundy and Davis, 2013; Clarke et al., 2013). Moreover, the diversity and the situated character of this knowledge are expressed in terms of the different knowledge systems that are involved in coastal governance (Gerhardinger et al., 2009; Evans, 2010; Hastings et al., 2012; Clarke et al., 2013; O'Toole & Coffey, 2013). Second, the coastal governance literature proposes a variety of approaches for connecting or integrating these disparate kinds of knowledge. Institutional approaches include proposals to improve interfaces between knowledge creation and decision-making, for instance by creating flexible institutions for adaptive management, in which stakeholders can interact and evaluate the effects of management measures on an ongoing basis (Bremer & Glavovic, 2013a), and by instituting boundary organizations (Tribbia & Moser, 2008). The latter "play an intermediary role between knowledge creation and decision-making (in different domains and levels) with a view to achieving co-operation in relation to

a shared objective" (Clarke et al., 2013: 94). Process-oriented approaches include deliberation and dialogue (Le Heron et al., 2008; Clarke et al., 2013) and learning in the context of coastal governance practices (Jentoft, 2007; Evans et al., 2011).

This paper aims to contribute to the body of literature on knowledge in coastal governance by showing how an adaptive coastal governance practice can emerge and stabilize, in which actors with disparate knowledge systems collaborate towards the shared goal of sustainable resource use. Here, "stabilization" means the formation of a collaborative practice and the existence of this practice over a substantial timespan. Our research question is: what are the factors and conditions that are influential in this emergence and stabilization? We argue that this emergence and stabilization needs to be understood in terms of the reciprocal relationship between the formation of epistemic order and regulatory order. Epistemic order refers to the establishment of knowledge systems, how knowledge disputes are dealt with, and how actors collaborate in knowledge creation. Regulatory order refers to policy-making, regulation practices, and jurisdiction. This reciprocal relationship, also referred to as coproduction (Jasanoff, 2004), is an aspect of knowledge-policy relationships that has hitherto been scarcely addressed explicitly in the coastal governance literature.

The next section describes the analytical framework in further detail, after which section 2.3 outlines the methodology and section 2.4 introduces the case of the mussel fishery in the Dutch Wadden Sea. Subsequently, section 2.5 describes the empirical results of the case study and section 2.6 provides our conclusions on the role of knowledge systems and the coproduction of knowledge and policy in coastal governance.

2.2 THE COPRODUCTION OF KNOWLEDGE SYSTEMS AND POLICY ARRANGEMENTS

In this study, we use the concept of coproduction as a general interpretive framework for the interrelationship between knowledge and policy (Jasanoff, 2004). In Jasanoff's words, "co-production is shorthand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it" (Jasanoff, 2004: 2). In this sense, the coproduction of epistemic and regulatory order means that the two are mutually constitutive. Rather than a "fully fledged theory, claiming lawlike consistency and predictive power", coproduction is "far more an idiom – a way of interpreting and accounting for complex phenomena […]" (Jasanoff, 2004: 3). The value of

this idiom is that "we gain explanatory power by thinking of natural and social orders as being produced together" (Jasanoff, 2004: 2). Coproduction provides an interpretive device that enables us to explain the interwoven character of knowledge and policy in the context of governance practices. It is better suited to do so than theoretical models that depict science and policy as separate worlds that interact through a predominantly one-way linear process, such as the "speaking truth to power" model of science and politics (Hoppe, 1999).

As an analytical framework to study epistemic order we will use the concept of the knowledge system, which we consider to be a "body of propositions actually adhered to (whether formal or otherwise) that are routinely used to claim truth" (Reid et al., 2006: 11). Furthermore, inspired by the concept of epistemic cultures, we will conceptualize knowledge systems as social systems of creating and warranting knowledge, which "make up how we know what we know"[9], and which are characterized by specific "machineries of knowledge construction" (Knorr Cetina, 1999: 1, 3). Thus, knowledge systems are social systems that are characterized by specific ways of creating, exchanging, and legitimating knowledge. This concept of the knowledge system entails a symmetrical analytical approach, in which different kinds of knowledge and conflicting viewpoints are investigated by means of a single framework, and in which no knowledge system is privileged "in terms of producing true or good knowledge" (Watson-Verran & Turnbull, 1995: 136). The concept enables us to identify differences between knowledge systems without reifying preconceived classifications and asymmetries of knowledge, for instance, between scientific and other knowledge (Knorr Cetina, 1999; Verran, 2001).

As a framework for analyzing regulatory order we will use the policy arrangements theory. Other authors have demonstrated the suitability of this theory for analyzing collaborative policy processes in the context of coastal management and marine policy (Bogaert et al., 2009; Seijger et al., 2013). A policy arrangement is defined as "the temporary stabilisation of the content and organisation of a policy domain" and is analyzed in terms of four dimensions (Arts et al., 2006: 96). The first dimension refers to actors (i.e., individual persons and organizations such as NGOs, fishing organizations, and governmental agencies) and coalitions. The second dimension refers to the division of power and resources among actors. Power is on the one hand regarded as "the ability of actors to mobilise resources in order to achieve certain outcomes in social relations", and on the other hand as a "dispositional and a structural phenomenon of social and political systems" (Arts & Van Tatenhove, 2004: 343). The third dimension concerns the rules of the game that are in operation. In this

9 The original italics are deleted.

case study we focus on rules in terms of national and international legislation and rules in terms of collaborative agreements such as covenants. The fourth dimension is discourse: "a specific ensemble of ideas, concepts, and categorizations that are produced, reproduced and transformed in a particular set of practices and through which meaning is given to physical and social realities" (Hajer, 1995: 44; Arts & Van Tatenhove, 2004). Discourses are thus dominant interpretative schemes, which include formal policy concepts, popular story lines, and views concerning norms, values, problem definitions, and possible solutions (Arts & Van Tatenhove, 2004; Arts et al., 2006). We use these four dimensions somewhat loosely as a heuristic and interpretive framework. The advantage of applying such a flexible framework is that it enables the identification of the most noteworthy aspects of the case as it enables a focus that is not too rigidly structured by theory. Moreover, the advantage of combining this multi-dimensional theory of policy arrangements with the concept of knowledge systems is that it enables us to identify various possible ways in which knowledge is interconnected with specific aspects of policy-making and regulation such as power and rules.

2.3 METHODS

This case study is empirically informed by interviews, focus groups, and document analysis. A total of 28 semi-structured interviews were conducted with actors who were involved in the collaborative practice concerning the mussel fishery in the Dutch Wadden Sea or in the processes that preceded this collaboration. The majority of the interviewees were intensively involved for many years, both before and during the collaboration. Therefore, the set of interviews has provided rich information on how the collaborative practice emerged, stabilized, and functioned during the last decade. The interviews were held in two rounds: an exploratory round in 2012 of 8 interviews, and a second round of 20 interviews in 2013. Most of these interviews lasted between 45 minutes and 2 hours. Interview questions were formulated according to the analytical framework described above. The interviewees were representatives of the mussel sector, government officials, representatives of the NGOs involved, and scientific experts. The interviews were recorded, transcribed verbatim, and coded with software for qualitative data analysis (QSR Nvivo 10). Two types of codes were used: setting-specific codes, which emerged inductively from the data (such as current issues concerning the case), and analytical codes, which were derived from the analytical framework (Lofland et al., 2006). The coded data was stored in an Nvivo project database.

Moreover, three focus groups with between 3 and 8 participants were conducted with representatives of the NGOs involved, civil servants from the Department of Economic Affairs,[10] and representatives of recreational sailing organizations and the shrimp fishing sector. The focus groups were held to validate findings from the interviews, collect additional data, and identify problem formulations and perspectives of groups of actors involved on a more intersubjective level as compared to the individual interviews. The set-up of the focus groups was based on the methods developed in the Reflexive Monitoring in Action (RMA) approach (Van Mierlo et al., 2010). The focus group sessions were recorded and the data was processed and analyzed in a similar way to that of the interview data.

Furthermore, we used case-related documents such as policy documents, research and advisory reports, and progress reports. In our analysis we applied triangulation of interview transcripts, focus group transcripts, and case-related documents to validate the results (Hastings, 2010). We started out by analyzing the interview transcripts and focused on statements that were made by multiple interviewees as a first validation strategy. Subsequently, we used the focus group transcripts and case-related documents to validate the analysis of interview data; we used these sources to enrich our analysis with additional data. The quotes in this paper are anonymized to meet the confidentiality agreement that was agreed upon with the interviewees and the focus group participants.

2.4 THE MUSSEL FISHERY AND MUSSEL CULTIVATION IN THE DUTCH WADDEN SEA

The Wadden Sea, which stretches from the northwestern coast of the Netherlands to the southwestern coast of Denmark, is a coastal wetland area of both ecological and socioeconomic importance. It contains intertidal sand and mud flats, salt marshes, and barrier islands. Its value as a nature area is, for instance, reflected by its inscription on the UNESCO World Heritage List. Mussel beds (*Mytilus edulis*) are considered an important element of the Wadden Sea ecosystem (Dankers and Zuidema, 1995).

Mussel cultivation in the Netherlands originated in the southwestern delta of Zeeland. Traditionally, Dutch mussel culture is a semi-culture, in which mussel spat resulting from natural reproduction is fished from the "wild" seabed, cultivated on plots that are rented from the government for some two years, and then brought to market (Van Ginkel, 1990; Smaal, 1991). From around 1950 onwards, mussel fishermen started to cultivate mussels on plots in the Wadden Sea since the mussel population

10 Formerly the Ministry of Agriculture, Nature, and Food Quality.

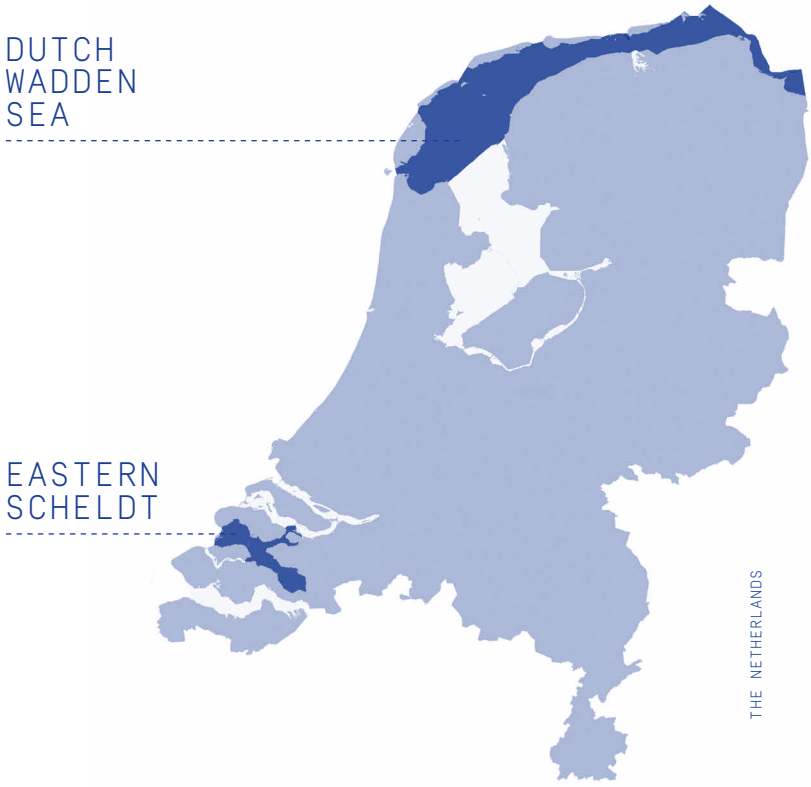

Figure 2.1: The Dutch Wadden Sea and the Eastern Scheldt

in Zeeland was severely affected by a parasite (Dankers & Zuidema, 1995; Ens et al., 2004). Since then, they have been using both the Wadden Sea and the Eastern Scheldt (Oosterschelde) in the southwestern delta for collecting and cultivating mussels (see figure 2.1). Until the early 1990s, the mussel fishery was a relatively "free" fishery under limited regulation (Van Ginkel, 1990).

In the early 1990s, low spat falls of both cockles and mussels occurred (Floor et al., 2013). The remaining intertidal mussel beds and "almost all dense cockle beds" were removed by the mussel and cockle fisheries, which resulted in food shortages among birds and eventually in a high bird mortality (Dankers & Zuidema, 1995: 78). These events spurred conflicts and

legal procedures between the fishing sector and nature conservationists involving the impact of shellfish fisheries on the Wadden Sea ecosystem (Imeson & Van den Bergh, 2006). However, a broad scientific consensus on this matter was not reached; scientific knowledge was "continuously debated" by experts and other actors involved (Turnhout et al., 2008: 233). Despite this lack of scientific and societal consensus, a stricter fisheries policy based on the principle of comanagement was introduced in 1993 (Steins, 1999). Key principles of this policy were a "division of responsibilities" between the fishing sector and the government and "the integration of fisheries and nature", for instance by means of food reservation for birds (Steins, 1999: 130).

In 2004, a revised shellfish fisheries policy was introduced, which emanated from the yet unsettled conflicts between the fishing sector and environmental NGOs, deliberations between various actor groups involved, and a series of research and advisory reports on shellfish fisheries and sustainable development of the Wadden Sea (Adviesgroep Waddenzeebeleid, 2004; Ens et al., 2004; Swart & Van Andel, 2008; Runhaar & Van Nieuwaal, 2010). This revised policy encompassed a ban of the mechanical cockle fishery from the Wadden Sea as of 2005 and investments in economically and ecologically sustainable mussel fisheries.

Between 2004 and 2008, both Dutch and European courts of law handled new court-cases that were instituted by the NGOs. The latter argued that the shellfish fishing permit regime was insufficiently attuned to nature conservation. These procedures culminated in 2008 in the nullification by the Dutch Council of State of the mussel spat fishing permit that was issued in the spring of 2006. This situation created the leverage to find a structural solution for a sustainable mussel fishery. Later in 2008, the Dutch government, the Producers' Organization (PO) Mussel Culture, and a group of environmental NGOs[11] signed the "Transition Mussel Sector and Nature Restoration Wadden Sea Covenant".[12]

The first key element of the covenant is the step-by-step replacement of the seabed spat fishery by alternative methods of spat collection in the water column, in order to minimize the ecological impact of the mussel spat fishery on the seabed (see also Puente-Rodríguez et al., 2015). With each transition step, parts of the wild mussel spat beds are closed for nature restoration purposes. The main alternative method so far deployed involves the use of mussel spat collection installations (Dutch acronym: MZIs[13]). MZIs are floating constructions of lines, pipes, or rafts, which are anchored to the seabed and have ropes or nets ("substrate") hanging in the water. Mussel spat, which floats in the water column in its first stages of

11 The signatories of the covenant are the minister of Agriculture, Nature, and Food Quality; the Society for the Protection of Birds; the Wadden Sea Society; the WAD Foundation; the Society for the Preservation of Nature Monuments in the Netherlands; and the Producers' Organization Mussel Culture.

12 In Dutch: Convenant Transitie Mosselsector en Natuurherstel Waddenzee.

13 MZI stands for mosselzaadinvanginstallatie (literally: mussel seed collection installation).

development, adheres to the substrate and can subsequently be harvested and cultivated. Other alternatives to spat collection on the seabed, such as MZIs on the North Sea and mussel reproduction and cultivation in more industrial settings on land, are also being explored in order to eventually further diminish mussel spat collection in the Wadden Sea. The second key element of the covenant is a nature restoration program for the Wadden Sea,[14] which encompasses a wide array of nature restoration initiatives.

Despite the collaborative effort around the covenant, the mussel transition is contested. For instance, the mussel sector doubts the necessity of fully completing the transition for several reasons, which include the conviction that the spat fishery on the seabed has a limited ecological impact. Thus, they question the very foundations of the covenant and the transition. Other groups of actors are also critical about the mussel transition. For instance, the increase of MZIs and closed areas decreases fishing grounds for shrimpers. Furthermore, recreational sailing organizations oppose the transition as MZIs may lead to unsafe situations for sailors and are found to be aesthetically unattractive.

2.5 RESULTS

In this section we will first describe the roots of the conflict concerning the mussel fishery in the Dutch Wadden Sea in terms of a clash between two perspectives on using and protecting natural resources: a mussel fishery perspective and a nature conservation perspective (section 2.5.1). Subsequently, we will describe two examples of knowledge creation efforts, which exemplify the knowledge dynamics that have occurred in the context of these conflicting perspectives (section 2.5.2). Finally, we will explain how the two perspectives were connected in a governance practice through the coproduction of power, rules, and collaborative knowledge creation (section 2.5.3).

2.5.1 The Wadden Sea mussel conflict as a clash of two perspectives

At the basis of the Wadden Sea mussel conflict lies a clash of two dominant perspectives: a mussel fishery perspective and a nature conservation perspective. We use the term "perspective" to describe a more or less coherent unity that encompasses interconnected discourses and knowledge systems. We are aware that, within both the nature conservationist sector and the fishing sector, different approaches and viewpoints exist that sometimes

14 The Program "Towards a Rich Wadden Sea" (PRW).

overlap (e.g., Van der Windt et al., 2007). However, during this conflict the two contrasting perspectives described here were dominant.

2.5.1.1 THE MUSSEL FISHERY PERSPECTIVE

The idea that mussel fishermen are "farmers on the water"[15] who produce and "work in nature" is a key story line in the mussel fishery discourse. Several interviewees stated that they "live on nature", implying that they depend on nature for their livelihood and therefore are responsible for keeping their workplace territory in good condition. Moreover, they argued that mussel cultivation is a type of "nature management"; because mussel spat is "safely stored" and cultivated, mussel cultivation enriches nature.

This discourse is founded on truth claims concerning nature, the mussel fishery, and how nature and the mussel fishery are interrelated. Interviewees described nature as capricious, autonomous, and dynamic. For instance, one of them argued that "nature does what it wants"; another interviewee argued:

> "Processes in the area are so autonomous, our activities so to say brush against them. […] Destroying the Wadden Sea: a mussel fisherman is not able to do that."

Moreover, the spat fishery on the seabed is perceived to have a limited impact on nature. Furthermore, the fishermen see mussel cultivation as beneficial to nature as it increases mussel biomass and thus food for birds in the Wadden Sea. Many of them work in family businesses, which have sometimes been using the same plots for several generations. This serves as an argument for the sustainability of mussel cultivation:

> "Here in the Eastern Scheldt […] we have been fishing for 100 years on a plot of our own […]. If we caused significant damage we would be done fishing sooner or later."

In addition to these truth claims about the interrelationship between fisheries and nature, the mussel fishery discourse is strongly founded on truth claims concerning economic and operational management aspects of the fishery practice and its current transition. Several interviewees stressed the high investments necessary for the transition and the relatively high price of MZI-caught spat; also, they expressed their concerns about the efficiency and the returns of these new production methods. These economic considerations have served as arguments for the claim that the goal

15 All of the quotes in this section are from interviews with actors from the mussel sector; most of them have practical experience as fishermen. The short quotes at the beginning of the section are statements that were made in multiple interviews.

of a fully completed transition is unattainable. Moreover, the fishermen argued in the interviews that the MZI-based practice sometimes conflicts with the traditional spat collection and cultivation cycle and that the new methods are much more laborious than the traditional ones.

On the one hand, the mussel fishery knowledge system is traditional in the sense that many fishermen work in family businesses and acquired their knowledge from their fathers or other family members. Moreover, the knowledge system has a strongly experiential character, as mussel cultivation is not a trade that mussel fishermen learn in school; they learn the tricks of the trade by seeing their colleagues and family members work, and trying it themselves. Furthermore, the knowledge system has a local character; to be able to do his work, a mussel fisherman needs knowledge about local conditions, such as the suitability of specific cultivation plots for parts of the cultivation cycle. For instance, one of the interviewees explained about one of his cultivation plots:

> "It is very good for sowing seed and taking it off a year later as juvenile mussel […] from juvenile to consumption-sized mussel, it doesn't work."

On the other hand, the mussel fishery knowledge system has become increasingly formalized through research, monitoring, and collaborations between the sector and research organizations. This formalization occurred under pressure from regulation, legal cases, and agreements that were made in the context of the mussel covenant. Examples of regulation-induced, formalized knowledge creation include periodic inventories of mussel stock, black-boxing of ships, and making scientific "appropriate assessments" of the effects of fishing practices that need to accompany permit requests under the Nature Conservation Act. Moreover, new fisheries policies have led to research efforts. According to mussel fishermen, the results of these research projects validate and objectify their experiential knowledge. The mussel sector has close ties with a number of experts and research organizations such as IMARES.[16] It collaborates with the latter by, for instance, financing research on the yield of cultivation plots and by organizing "study days".

The mussel fishery knowledge system is thus partly traditional, but it is also part of an economic sector engaged in processes of innovation and transition. The success of the MZI technology can at least in part be attributed to the experiments, innovations, and adaptive capacity of both individual fishermen and companies. For instance, one of the interviewees argued that "you need to be open to modernization in your cultivation."

16 Institute for Marine Resources and Ecosystem Studies, part of Wageningen University.

2.5.1.2 THE NATURE CONSERVATION PERSPECTIVE

In the nature conservation discourse, the Wadden Sea is first and foremost a nature area. Furthermore, "restoration"[17] of nature is a key concept within this discourse. Nature is defined in terms of an ecosystem, the state of which is described in terms of its biodiversity and the functioning of its "food web". Restoration of the ecosystem is seen as a long-term and large-scale process. Within this discourse, mussels are framed in terms of their structural role in the ecosystem. For instance, "wild multiple-year mussel beds" are a nature restoration objective because mussels serve as a "bio-builders".[18] The development of such mussel beds must take place in a way that is as "undisturbed" as possible; therefore, "seabed disturbing" fishing activities must be banned. Hence, "coming loose from the seabed" is the central objective of the transition for the nature protection NGOs involved. The mussel fishery is described as a form of "human co-use", which is only allowable within the "usage space" defined by "nature objectives". For instance, one of the representatives of the NGOs argued:

> "[Our organization] is of the opinion that the types of co-use, where they do not match the nature objectives, should be discontinued or brought into conformity with the nature objectives for the area."

This nature conservation discourse is underpinned by truth claims as to the beneficial impact of wild mussel beds on the ecosystem. For instance, interviewees argue that mussel beds are the foundation of the ecosystem and are important for many species because they form habitats on the seabed. Furthermore, this discourse is underpinned by claims that the mussel fishery has a negative impact on the ecosystem. For instance, one of the representatives of the NGOs stated:

> "Mussel beds have an enormous impact on their surroundings, so if you take away a mussel bed, you don't just take away a couple of mussels but you take away a bio-builder […]."

The knowledge system of the nature protection NGOs involved in the transition is strongly rooted in scientific ecosystem ecology. A science-based image of the ecosystem serves as a frame of reference within this

17 All of the quotes in this section are from the interviews or the focus group with representatives of the NGOs. The short quotes at the beginning of the section are statements that were made in multiple instances.

18 The term bio-builder refers to species that through their physical characteristics may create habitats for other species.

knowledge system. Interviewees have expressed their preference for a scientific knowledge base; for instance, one of them argued:

> "We as nature conservationists are looking for internationally published science, which was assessed in peer review, as a foundation."

In addition, an ideal image of nature serves as a frame of reference; according to the NGOs, nature should be under no or very limited pressure from human activities, and the latter should pose no risk to the ecosystem. This ideal is a structuring element of the knowledge system as it plays a role in determining which type of research is deemed relevant and important, and which is not.

Many of the representatives of the NGOs involved in the mussel transition have science-based ecological expertise and the NGOs have many members who are amateur field biologists. Moreover, some of these organizations have employees who keep up to date with research reports and the scientific literature. The coalition of the NGOs serves as a network for intensive knowledge exchange. Furthermore, the NGOs have both formal (e.g., as clients of scientific reports) and informal ties with scientists and experts. For instance, one of the interviewees argued:

> "There are very strong connections between science and nature conservation. There are the people at NIOZ[19] and the ornithologists at SOVON,[20] those relationships have been very strong traditionally."

Some scientists with an active stance in nature conservation and fisheries controversies, for instance, from the University of Groningen, are criticized by representatives of the mussel sector for being too closely connected to the nature conservation movement and for having lost their scientific objectivity. Steins (1999: 136) describes such scientists as "political biologists".

Whereas the contrast between the perspectives is apparent, there is also common ground between them. Both perspectives do not exclude human intervention in nature, although they differ on the degree and goal of the intervention. Moreover, both perspectives draw on biological science as a source of legitimation and are informed by local and informal knowledge at the same time. Finally, respect for nature forms a part of both perspectives.

19 Royal Netherlands Institute for Sea Research.
20 Dutch Centre for Field Ornithology.

2.5.2 Knowledge creation in the context of conflicting perspectives: two examples

The case of the Wadden Sea mussel transition is characterized by a variety of knowledge creation efforts. Some of these efforts were the subject of ongoing contestation, whereas others were productive in terms of collaboration and outcome. In this section we will describe two examples of such efforts. We will deal with these examples at some length as they simultaneously convey several key issues and patterns that are of importance for insight into this case. Notably, the two examples:

1. show the different types of difficulties and obstacles for knowledge creation in a governance context that stem from the conflicting perspectives;
2. illustrate the different ways in which knowledge creation efforts can play a crucial role in the emergence and stabilization of a coastal governance practice;
3. convey contrasting aspects of knowledge creation, which inform our identification of aspects of productive knowledge creation in a governance context.

Moreover, by providing a chronological account of these two knowledge creation efforts, we will show how the role of such efforts in governance may shift over time and how productive knowledge creation for coastal governance can be a lengthy step-by-step process.

2.5.2.1 THE PRODUS RESEARCH

The Dutch government initiated the research project PRODUS[21], which was started in 2006, in order to support the sustainable development of the mussel fishery by filling a number of knowledge lacunae. These lacunae concerned, among other issues, alternative forms of spat collection and mussel cultivation and the ecological effects of the mussel fishery in permanently flooded areas in the Wadden Sea. The research was executed by scientists from several research organizations, including IMARES and NIOZ, and had a natural-scientific character; it was cofinanced by the Dutch government and the mussel sector.

In 2007, PRODUS became one of the topics in new deliberations between the government, the mussel sector, and NGOs on the future of the mussel fishery in the Wadden Sea. The NGOs expressed their doubts about the research set-up and thought that PRODUS was biased, in the sense that it was mainly aimed at facilitating the fishing permit regime.

21 Dutch acronym for Research Sustainable Shellfish Fishery Project.

A year later, PRODUS played a decisive role in the legal procedure against the mussel spat fishing permit of spring 2006 (see section 2.4). According to the law such a permit may be granted if the permit request is accompanied by an ecological assessment, which excludes adverse effects on nature conservation objectives. The Council of State qualified the results of PRODUS as "essential to be able to assess the effects of the permitted activity for the natural characteristics of the Wadden Sea"[22]. However, PRODUS could not meet this knowledge requirement as it had not yet produced conclusive results. Consequently, the Council of State nullified the permit. Thus, the mere fact that PRODUS existed, and not the knowledge it had produced, played a decisive role in the verdict (Herman et al., 2008).

After the verdict, the Dutch parliament and the parties involved in the deliberations discussed whether PRODUS's research questions and methodological set-up were adequate and whether the project could be adjusted and accelerated in order to settle the mussel conflict. A scientific audit of PRODUS, commissioned to answer these questions, concluded that the research questions were formulated adequately albeit narrowly and that some methodological and statistical adjustments were necessary (Herman et al., 2008). The audit also concluded that speeding up the research would be impossible as the recovery of mussel beds is a long-term process; producing valid results would take at least ten years. It thus became clear that PRODUS would not be able to settle the mussel conflict in the near future, as the short-term dynamic of the social-political controversy on the mussel fishery was not compatible with the long time scale of ecological recovery. Dealing with such incompatible time scales can be a key challenge for coastal governance (Clarke et al., 2013: 93).

The audit committee also formulated an unsolicited critique concerning the role of knowledge in the mussel conflict. It pointed out the fundamentally different "visions"[23] concerning the Wadden Sea among the parties involved: a user vision that focuses on how to improve mussel culture, and a conservationist vision that focuses on how to bring the ecosystem into an "ecologically richer state" (Herman et al., 2008: 6). The committee therefore concluded that the PRODUS research on the ecological effects of the conventional mussel fishery is "viewed by none of the directly involved parties as desired, well-spent, or necessary research" (Herman et al., 2008: 6).

In spite of these objections, PRODUS was continued and reframed as one of the activities contributing to the collective research and monitoring program of the mussel transition. However, the project remained contested among the covenant partners. Representatives from the mussel

22 Council of State, 2008. Judgment 200607555/1.

23 What the committee calls "vision" is similar to what we call "perspective".

sector are pleased with the results of the project. They argue that PRODUS scientifically proves that the mussel spat fishery has some influence but does not damage the Wadden Sea ecosystem; thus, they argue that a full transition is not necessary. Representatives of the NGOs, in contrast, remain critical of the project as it remains incompatible with their nature restoration perspective. They argue that PRODUS does not provide insight into processes of nature restoration due to the small scale of the plots, the short term of the research, and the fact that the research does not focus on the nature restoration efforts that are made in the context of the transition. However, they also see parts of the research results as useful, for instance, in as much as PRODUS provides knowledge about the effects of mussel beds on biodiversity.

The example of PRODUS shows the difficulties of underpinning a coastal governance practice with scientific research. In this case, the controversy concerning the research topic reinforced the contestation of the research project. Furthermore, as the actors involved have different perspectives that provide different interpretive frameworks, they assess the relevance, the quality, and the results of the research differently. Therefore, the research failed to become an uncontested source of knowledge for the governance practice.

2.5.2.2 THE SOUTH-NORTH TRANSPORTS

The transport of mussel spat from the Eastern Scheldt to the Wadden Sea has been a principal topic of conflict between the mussel sector and the NGOs in recent years. From the mussel fishery perspective, such "south-north transports" (SNTs) are essential to optimize the profitability of their cultivation practice. The Eastern Scheldt, which is less dynamic than the Wadden Sea, provides good conditions for collecting mussel spat on MZIs and for "safely storing" mussel spat in winter. The Wadden Sea, with its higher nutrient load, provides more productive cultivation areas. As spat from MZIs is relatively expensive due to capital and labor costs, mussel fishermen want to use their best plots to store it and to cultivate it profitably. For instance, one of the fishermen interviewed argued:

> "The south-north transports give every company the room to handle its stock better, […] to probably cultivate a bit more mussels than we have been doing until now, because you, for instance, safeguard them in the Eastern Scheldt and cultivate them faster in the Wadden Sea."

From the nature conservation perspective, SNTs are problematic. The key problem is that these transports pose a sheer insurmountable risk of introducing invasive exotic species into the Wadden Sea. The Eastern Scheldt harbors several exotic species of plants and animals which are not known in the Wadden Sea. Representatives of the NGOs stress that the effects of introducing such species into the Wadden Sea ecosystem could be devastating and irreversible.

Since signing the covenant in 2008, the covenant partners have been engaged in ongoing efforts to find a solution for the issue of the SNTs. In the execution plan of the transition they agreed that transports were only possible within "ecological conditions".[24] However, it was not immediately clear what these conditions were. Therefore, a working group was appointed, which organized expert meetings, performed a literature review, made a risk analysis, and issued research on the prevalence of exotic species in the Wadden Sea. This research resulted in an inventory report on exotic species in the Wadden Sea and a "quick scan" of exotic species in the Eastern Scheldt (Gittenberger et al., 2009). From these new insights the covenant partners concluded that a number of exotic species found in the Eastern Scheldt were probably not present in the Wadden Sea, and that some of these species could be transported via mussel spat transports. Subsequently, they concluded that SNTs would not be possible until a monitoring program for "effective prevention and management of exotic species" and a "coherent exotic species policy" were in place.[25]

The monitoring protocol for SNTs was based on a protocol previously applied to the import of shellfish from Ireland and Great Britain into the Eastern Scheldt. It includes periodic species inventories (SASIs[26]) on isolated cultivation plots in the Eastern Scheldt and sampling the load of the fishing ships before they enter the Wadden Sea. This approach was formalized in 2012 in "policy rules" concerning shellfish relocation into the Eastern Scheldt and from the Eastern Scheldt to the Wadden Sea.[27] These include rules concerning integral risk assessment, risk management, and monitoring.

In spite of this progress, the covenant partners had not yet reached agreement on structural provisions for the SNTs by 2012. In that year pressure arose to allow transports, since the fishermen had become more dependent on spat from MZIs, including those in the Eastern Scheldt, due to low spat fall on the seabed in the two preceding years. Consequently, the covenant partners agreed on a one-off "emergency provision". Transports were allowed under the risk management and monitoring protocol,

24 Plan van Uitvoering Convenant Transitie Mosselsector en Natuurherstel Waddenzee, 3 februari 2010.

25 Op. cit. footnote 24: 39.

26 Shellfish Associated Species Inventory.

27 Staatscourant, 2012, Beleidsregels van de Staatssecretaris van Economische Zaken, Landbouw en Innovatie van 6 juni 2012, nr. 267278, Houdende vaststelling van beleidsregels inzake schelpdierverplaatsingen.

complemented with additional measures to accommodate the demands of the NGOs, such as planning the transport in early April, when the water is cold and activity of possibly harmful species is still low.

In 2013, the Producers' Organization (PO) decided to request a permit for SNTs without consulting the other covenant partners, in order to "force a breakthrough". Later that year, the ministry issued a new temporary permit for SNTs under the conditions of the risk management and monitoring protocol. In early 2014, this permit was extended to a year-round permit. Thus, the provisions for the transports have gradually become more structural as a result of the ongoing coproduction of knowledge and rules of the game.

The example of the south-north transports illustrates the difficulties of finding a common ground between user and conservationist perspectives on issues of risk and uncertainty. The representatives of the mussel sector argue that the monitoring and risk management protocol is more than sufficient. Moreover, they feel that the NGOs force them to take more precautionary measures than necessary. Representatives of the NGOs state that they are satisfied with all the knowledge concerning invasive exotic species that has been produced over the past few years, and with the systematic and well-organized risk management regime that has been developed. However, they continue to see the transports as problematic, since the protocol is based on statistical sampling, and thus a risk always remains.

This example also shows how a solution to such a clash of perspectives can be brought closer step by step. The actors involved engaged in an ongoing process of creating knowledge and negotiating the rules of the game within the context of the covenant collaboration. This process turned an opaque issue into a manageable risk over the course of five years. In the next section, we will expand on this process of knowledge creation and rule formulation as key elements of collaborative governance.

The examples of PRODUS and the south-north transports show the different knowledge dynamics that may occur in the context of conflicting perspectives. In the former example, distrust and conflicting assessments of quality and relevance of research were key issues that remained unresolved. In the latter example, the two perspectives manifested themselves in conflicting risk perceptions; a step-by-step knowledge creation process integral to the collaborative practice proved to be a productive approach for dealing with this conflict.

2.5.3 The mussel transition: connecting the two perspectives

Since 2008, the mussel fishing sector, nature conservation NGOs, and the Dutch government have been engaging in a collaboration aimed at the combined goals of nature restoration and an economically feasible mussel fishery in the Dutch Wadden Sea. How did the stabilization of this collaborative practice come about, given the conflicting perspectives between these parties? We will explain this stabilization in terms of three interrelated aspects: power, rules, and collaborative knowledge creation.

2.5.3.1 JURISDICTION, POWER, AND THE PRESSURE TO COLLABORATE

In 2004, the European Court of Justice ruled that the mechanical cockle fishery was a "plan" or "project" under the European Habitats Directive; therefore, appropriate assessments proving the absence of adverse effects on the nature conservation objectives needed to accompany permit requests. Cockle fishing permits were only to be granted if "no reasonable scientific doubt remains as to the absence of such effects".[28] In 2005, the Dutch Council of State ruled that this requirement of making an appropriate assessment also applied to the mussel fishery. Later that year, the Dutch Nature Conservation Act was altered so as to include the legal requirements of the European Birds and Habitats Directives.

This series of legal events, culminating in the nullification of the mussel fishing permit by the Council of State in 2008, constituted a legal-political shift in the furnishing of proof (see also Herman et al., 2008). It imposed the burden of proof on a party requesting a permit, *in casu* the mussel sector. This proof was to be given in an assessment based on the best available scientific knowledge. Moreover, the law was formulated according to the logic of the precautionary principle, which implies a "negative" burden of proof; the mussel sector had to prove the absence of effects from its activities on the nature conservation objectives. This shift is legal in that it is grounded in national and European legislation and jurisdiction; it is political in that it constituted a shift in the power balance between parties who had been engaged in an ongoing controversy concerning the use and protection of the Wadden Sea.

The nature conservation NGOs gained a strong power position through the verdict of February 2008; in the words of one of the interviewees, the verdict "sealed the shift of power" that had been going on for a longer time. The end of Dutch mussel culture, instigated by the NGOs, was a plausible short-term scenario in the eyes of all parties involved. For instance, one of

28 Court of Justice Judgment of the Court (Grand Chamber) of 7 September 2004 in Case C-127/02. Court of Justice, Luxembourg, 7472.

the representatives of the NGOs explained that part of their constituency argued for a full ban on the mussel fishery after the verdict:

> "[Part of the constituency said] lad, you have won the legal case, they don't have a permit anymore, now carry it through. That is not my approach but a minority of the constituency put us under pressure in that direction."

One of the interviewees from the mussel sector described the sentiments after the verdict as follows:

> "It was like 9-11 for the mussel sector. Everybody still knows where he was on that day. […] Grown-up men were crying, simply the end of the story. […] Doing this for centuries and then [the NGOs] say that what you are doing is so wrong that you can't do it anymore. You felt affected in every fiber of your body."

In reaction to the verdict, the mussel fishing community started campaigning against the NGOs under the slogan "Stop the Green Lie". National newspapers reported about the predicament this community was facing, and members of parliament and top administrators became involved in the public debate about the conflict. One of the issues the debate focused on involved the funding sources of the NGOs. For instance, appeals were made to boycott the *Postcodeloterij* (Postal Code Lottery), an influential sponsor of societal initiatives and "good causes" such as nature conservation NGOs. With their campaign, the fishing sector succeeded in drawing political and societal attention, and in increasing the pressure on the NGOs and the government.

After the verdict, in order to find a solution the Minister of Agriculture, Nature, and Food Quality became personally involved in the conflict by entering, for example, into consultation with managers of the NGOs involved. Moreover, the Royal Commissioner of the province of Zeeland began a dialogue with the NGOs. This strong political support to find a way out of the situation resulted in the involvement of top civil servants.

Negotiations as to the future of the mussel fishery had already been going on for a long time. However, the verdict of the Council of State, the involvement of top politicians and administrators, and the fervent campaign of the fishing community created a necessity; this series of events created strong pressure on all parties involved to find a solution. The immediate pressure was abated through a set of agreements, which are formulated in the covenant and execution plan. These agreements reflect the skewed

power balance between the NGOs and the fishing sector. They enabled the relatively powerful NGOs to instigate both a drastic transition of the fishery and a nature restoration program for the Wadden Sea, which are activities that are in line with their "core business". Mussel fishermen argue that they were "with their backs to the wall" and describe the agreements as a "forced marriage". The agreements induced them to invest in MZIs and concomitant alterations of operational management, and to allocate financial resources for research and monitoring.

2.5.3.2 THE RULES OF THE GAME AND THE ACTORS ON THE PLAYING FIELD

The rising pressure created a precondition for forging a collaboration; many rules and agreements were needed in order to make the collaboration function. The mussel covenant of 2008 was a first set of agreements between the Minister of Agriculture, Nature, and Food Quality, the Mussel Culture PO, and the NGOs. The covenant includes agreements both on an economically viable mussel sector and on a nature restoration program for the Wadden Sea; therefore, the covenant itself is a materialization of the connection between the perspectives of the mussel fishery and nature conservation. The execution plan of 2010 contains further agreements concerning the mussel transition.

The following agreements are key rules of the game, which have constituted a workable collaboration. First, the parties have agreed to refrain from undertaking further legal actions or public campaigns against each other. Instead, they have started to work together constructively. Second, they have agreed to work towards a shared future goal: In 2020, mussel spat collection on the seabed is to be replaced by alternative means of spat collection. Third, they have agreed to apply a type of adaptive management ("learning by doing") in order to reach their goal.[29] Since the transition path through to 2020 is surrounded by many uncertainties, for instance, in terms of "the success of MZIs, the effects on nature of such installations, nature development", along with deliberations with other actors, the transition is designed as a recursive process of experimenting, scaling up, monitoring, evaluating, and adjusting.[30] Moreover, the speed of the transition steps depends on MZI yield; therefore, the transition path is contingent upon both the success of innovation and upon natural variability. Fourth, the parties have agreed on applying specific technologies, notably MZIs, which serve their mutual interests. MZIs make the mussel fishermen less dependent on natural variability; they provide them with a relatively constant supply of mussel spat (Programma Naar een Rijke Waddenzee, 2012). For the NGOs, MZI technology is an important key in

29 Op. cit. footnote 24: 16.
30 Op. cit. footnote 24: 16.

reaching their goal to "come loose from the seabed", since other alternatives to seabed spat collection are still in an earlier experimental stage.

Besides the rules of the game, the execution plan also describes a "playing field", in which ongoing deliberation, negotiation, and creation and exchange of knowledge take place. This playing field is governed by two committees: a managerial consultation group that supervises the execution of the mussel transition, and which serves as a strategic deliberation and communication platform for the covenant partners, and a project group that deals with technical and substantive aspects of the transition, and "prepares the decisions of the managerial consultation group".[31] According to the chairman of the execution plan process, this division of tasks worked very well during the realization of the execution plan, "but only because both groups strictly kept to their task description: creation and exchange of knowledge in the project group, strategic considerations in the managerial group".[32]

Representatives of the NGOs and the Mussel Culture PO, and civil servants of the Department of Economic Affairs are members of the committees. The latter play a facilitating role in several respects; for instance, they try to keep the dialogue between the covenant partners going, and they facilitate by providing a regulatory framework for the transition through formulating policy rules and providing permits. Other actors, including the shrimp fishing sector and sailing recreational organizations, have only a limited say, although they are affected by the mussel transition. In the "pressure-cooker" that arose after the Council of State verdict, the parties involved in the controversy have focused on forging a collaboration among the main actors and have refrained from setting up a more inclusive governance practice. As a consequence, these other stakeholders were not involved in key decisions about the mussel transition and had only limited influence, for instance, on MZI locations. In this sense, the covenant brought about a new distribution of power. The covenant partners combined forces and became a powerful coalition, whereas other stakeholders, although they are users of the same area, were given only a consultative role.

2.5.3.3 CREATING A SHARED KNOWLEDGE BASE

Since the transition process recursively connects research, monitoring, and action, a shared and uncontested knowledge base is essential. One of the fishermen involved, for instance, argued that prior to the transition,

31 Op. cit. footnote 24: 59.
32 Op. cit. footnote 24: 64.

> "the mistake was made that research projects were carried out and then there was major disagreement about results. […] We said: We have to tackle that from the start. Folks, we are entering this trajectory: Do we agree?"

Several interviewees used the term "joint fact finding" to describe the collective knowledge creation and exchange process that has emerged between project group members from both the NGOs and the mussel sector since the covenant was signed. As the chairman of the execution plan process described it, "the experts in the project group got along unexpectedly well […] it quickly became clear that [they] were able to respect each other's knowledge and considerations".[33] The knowledge creation involving invasive exotic species (see section 2.5.2.2) is an example of this joint fact-finding process.

The collective knowledge base of the transition encompasses two key elements. First, a monitoring program creates the factual data necessary for knowing the actual status of mussels in the Wadden Sea and the actual results of the transition efforts. This monitoring program includes periodic inventories of mussel stock in the western Wadden Sea (Van Stralen, 2012), monitoring of mussel spat yield in MZIs (Van Stralen, 2011), and monitoring of the development of mussel beds in closed nature restoration areas (Programma Naar een Rijke Waddenzee, 2013). Moreover, the periodic shellfish inventories in the Eastern Scheldt (SASIs, see section 2.5.2.2) can be seen as a part of this monitoring program. The monitoring is executed by a small group of experts, and produces data that is uncontested among the covenant partners. An important condition for this uncontested character is that the experts who execute the monitoring are trusted by all parties.

A second element of the knowledge base is the research program of the transition (not to be confused with PRODUS), which is executed by four research organizations[34] under the collective authority of the covenant partners; the latter share the "ownership" of this research. This program produces knowledge concerning relationships between the transition and the Wadden Sea ecosystem, notably on the ecological effects of scaling up MZIs. For instance, research has been performed on the effects of MZIs on the ecological carrying capacity of the Wadden Sea, the disturbance of wildlife by the operation of MZIs, and waste and pollution caused by the operation of MZIs (Programma Naar een Rijke Waddenzee, 2012). The covenant partners formulate research questions for this program, and they communicate the progress and results of the research in their annual progress reports.

33 Op. cit. footnote 24: 64.

34 IMARES, Deltares, NIOZ-Yerseke, and MarinX (Programma Naar een Rijke Waddenzee, 2012).

2.5.3.4 RE-ARRANGING THE POLITICS OF KNOWLEDGE

At the onset of the mussel transition, the role of knowledge with respect to the mussel fishery in the Wadden Sea shifted. This shift entailed a re-arrangement of the specific ways in which power, rules, and knowledge were coproduced. The pre-covenant era was dominated by an adversarial politics of knowledge, in which conflicting knowledge was at the core of the controversy and in which the actors involved mutually deployed or challenged claims of truth in order to settle the controversy to their advantage. Since the covenant was signed, a constructive politics of knowledge has emerged, which is characterized by collaborative knowledge creation in order to find a workable solution to the controversy. The politics of knowledge was re-arranged in three ways. First, the covenant states that its signatories will refrain from taking any legal actions against each other. Therefore, as long as the signatories adhere to the covenant, and they have strong incentives to do so, the covenant rules out the possibility of "systematically doubting proofs of no effect" as a means of power (Herman et al., 2008: 5). Second, the mussel transition curtails knowledge conflicts by means of a shared knowledge base. The monitoring data provide information with an interpretive flexibility different from that of PRODUS. This information has a strongly "factual", simple, and homogeneous character, and neither establishes cause-effect relationships nor provides explanations concerning controversial phenomena, such as the ecological impact of the fishery. Therefore, the monitoring data themselves are not complex, multifaceted, and interpretive enough to easily become the object of contestation or incongruous interpretations. The research program forms an integral part of the collaboration and thus has an inherently negotiated character and a shared ownership among the covenant partners. PRODUS lacked these characteristics of a shared knowledge base, which explains why it failed to become an uncontested source of knowledge for the mussel transition. Third, the layout of the "playing field" of the transition is designed to create a functional and productive division between the descriptive and the normative. The organizational structure of the transition curtails adversarial politics of knowledge by imposing a formal separation of explicitly substantive and explicitly strategic considerations.

2.6 DISCUSSION AND CONCLUSION

Conflicts on the use and protection of natural resources occur in coastal zones worldwide. This paper shows how such conflicts can be analyzed

in terms of clashes of user and conservationist perspectives. Knowledge is both a core element of the conflicts about natural resources in coastal zones and a key to their resolution.

Disparate knowledge systems may clash in the context of a governance practice, due to their normative and value-laden character. In the case presented in this paper, the mussel fishery knowledge system is, for instance, structured by tradition as a mode of creating and exchanging knowledge, and by economy as a key frame of reference. Since the mussel sector is interested in ways to sustain a profitable livelihood today and for generations to come, it is mainly interested in knowledge that may contribute to attaining this goal. In contrast, the conservationist knowledge system is structured by an ideal image of nature under limited human pressure, and by the goal to restore nature to an undisturbed and ecologically richer state; this point of view poses different knowledge requirements. Moreover, disparate knowledge systems may clash, since they constitute incongruous interpretive frameworks. As the example of the PRODUS research project shows, scientific knowledge, which is meant to provide knowledge for governance, may be interpreted quite differently in terms of user and conservationist perspectives. In this case, the relevance, quality, and results of the research were interpreted differently. This example illustrates the difficulties of underpinning a governance practice with a scientific knowledge base.

From the case presented in this paper, several lessons concerning integrated and inclusive governance can be learned that may be valuable in dealing with other conflicts on the use and protection of natural resources. Notably, this case demonstrates the productivity of an approach in which involved stakeholders settle disputes through mutual deliberation and the formulation of shared objectives instead of employing legal means. Moreover, a clear set of mutually accepted rules of the game concerning the collaborative practice is of the essence in conflicts such as this. Furthermore, our study confirms what several other authors have argued in the coastal governance literature, namely that adaptivity and learning are key elements of a productive governance approach; room for collective problem-solving can be created by negotiating a shared future goal and by adaptively working towards that goal. Finally, this case demonstrates the importance of putting knowledge and collaborative knowledge creation at center stage in a governance practice. From our analysis, we identify the following ways in which disparate knowledge systems can be accommodated in the context of collaborative governance:

1. Our findings suggest that a shared ownership of research efforts among actors involved in a governance practice enhances the integration of knowledge in governance. This shared ownership may involve the collective formulation of research questions, dialogue on the interpretation of results, and, subsequently, collective decision-making based on the results. This implies that research as an integral part of a governance practice better suits the requirements of that practice than research that is external to that practice, such as external scientific research projects.
2. A focus on data and knowledge with a "fact-like" character contributes to curtailing knowledge disputes in governance settings (cf. Van Buuren, 2009). In such a fact-oriented approach, monitoring of key parameters is of the essence for well-informed governance. Moreover, our results suggest that such an approach is enabled by formally or structurally separating substantive considerations and strategic or normative considerations. One way of doing so is by installing separate groups or platforms for strategy and knowledge creation.
3. Trusted expertise is an important issue for governance in controversial settings. In such settings, often a polarization of expertise arises, in which experts are distrusted and criticized for being too closely involved with either the conservationists or the users of natural resources (Steins, 1999; Turnhout et al., 2008). Therefore, it is advisable to involve experts in collaborative knowledge development who are closely connected to the governance practice and whose expertise is valued and trusted by all parties involved.

Our coproductionist perspective illuminates how knowledge creation and the regulatory setting in which this knowledge creation takes place are mutually constitutive. The case described in this paper is characterized by high pressure and controversy; the governance practice was forced into being. Such a situation strongly structures the setting for knowledge creation and gives rise to specific knowledge dynamics, such as knowledge disputes, joint fact-finding, and calls for independent audits of knowledge. At the same time, knowledge enables governance. This is exemplified by the shift from adversarial to constructive politics of knowledge: knowledge as a means of adversarial power was replaced by collaborative knowledge creation as a key element of governance.

Moreover, our analytical perspective that combines knowledge systems and policy arrangements illuminates the multitude of ways in which knowledge is interconnected with specific dimensions of policy. For in-

stance, various groups of actors involved in policy, such as stakeholders and policy-makers, are linked to different knowledge systems. The knowledge that exists and is created within these knowledge systems forms a part of specific discourses on how to use and protect natural resources. We may conclude that the combined analysis of discourses and knowledge systems provides insight into the conflicting perspectives of conservationists and resource users. Moreover, our results indicate that the collaboration between such groups of actors with conflicting perspectives can be facilitated by creating a shared knowledge system as a part of a governance practice. Furthermore, due to the legal rules of the game in this case, scientific knowledge is an important means of power that for instance can be deployed both for acquiring and challenging fishing permits. At the same time, our case shows that both the formulation of a shared set of rules and pressure that is created by political and societal power can play crucial roles in the formation of a collaborative governance practice and thus of a joint knowledge system that meets the requirements of the various actor groups involved.

Our account of the interrelation between knowledge creation and coastal governance clearly fits in with key debates on the relation between science and society in contemporary knowledge cultures. A main diagnosis within these debates is that knowledge creation increasingly takes place in heterogeneous social networks or "hybrid fora" and is characterized by a focus on social problem-solving and by a strong interconnection between societal interests and scientific considerations; a shift also referred to as the emergence of "Mode 2 science" or "post-academic science" (Ziman, 1996). This paper demonstrates that coastal governance practices are very suitable sites for studying such knowledge dynamics. Moreover, it demonstrates that the idiom of coproduction provides a suitable lens for investigating the dynamic and complex interrelations between knowledge and regulatory order in such settings. At the same time, this paper contributes to the further development of this theory by showing how an interdisciplinary analytical framework encompassing knowledge systems and policy arrangements provides a workable means for analyzing and interpreting such interrelations.

The mussel transition provides a *modus operandi* for dealing with the conflict involving the mussel sector, the government, and the NGOs. Yet, the governance practice, in which these parties have been engaging since 2008, has not fully settled the conflict. The mussel fishery in the Wadden Sea is still a contested issue, and it remains to be seen whether the collaboration will stand the test of time. A consequence of the governance approach described in this paper is that it occupies areas of the Wadden

Sea which are of value to parties other than the covenant partners. The paradox of this model of coastal governance is that it is inclusive of some actors, and exclusive of others. Therefore, the quest for more inclusive and integrated coastal governance is still ongoing. This quest may be furthered by means of an overarching integrated management structure that encompasses all forms of use and conservation of a coastal area and that connects the various governance practices in this area through coordination and knowledge and information exchange.

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